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CARBIDE AND FERROALLOY ELECTRIC FURNACES AS CONSUMERS OF SEASONAL HYDROELECTRIC POWER

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Special consumers of seasonal hydroelectric power have become of practical importance for regions with large hydroelectric power resources and a fuel balance problem. This is particularly true during the first stages of development of vast hydroelectric power resources before finished rayon and inter-rayon power systems have been put into operation. These regions include the Tadzhik SSR, the Kirgiz SSR, Eastern Kazakh SSR, the northern Caucasus, Transcaucasia, and the northwestern regions of the RSFSR, among others.

Previously, on the basis of the study and generalization of prolonged experiments in the operation of carbide and ferroalloy furnaces, the author worked out power engineering and economic characteristics which determine the conditions for efficient use of these industries as consumers of electric power, using the seasonal schedule of a hydroelectric station.

The cost structure of calcium carbide and ferrosilicon produced with power from a hydroelectric station operating on unregulated flow consists of the following factors:

1. Materials make up 25-30 percent of the cost of calcium carbide and 30-40 percent of the cost of ferrosilicon. The cost of materials is practically constant in passing over to the seasonal power schedule.

2. The wages of production workers constitute only a small percentage of the cost of calcium carbide and ferrosilcon. Thus, even substantial changes in the wages of production workers, while passing over to seasonal operation, cannot greatly influence the economics of the production of calcium carbide and ferrosilicon.

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3. The electric power component has a decisive influence upon the cost of production. When using electric power from steam-electric stations, the power component accounts for 40-45 percent of the production cost, while with hydroelectric power it comprises about 20-25 percent of the cost.

4. A number of overhead expenses are very important in determining the cost of production, comprising about 30-40 percent of the latter.

This limits possibilities of lowering production costs to the seasonal power schedule. Generalization of prolonged operational experience resulted in the establishment of new power-economic relationships in the operation of carbide and ferroalloy furnaces on the seasonal schedule of hydroelectric stations.

Contrasted with operation on a normal schedule, labor productivity is one of the most important indices of production efficiency under seasonal power conditions. On the other hand, unit consumption of electric power under the seasonal schedule (for a given installation and operating conditions) varies within the comparatively small limits of 3-7 percent and reaches 10 percent only in rare cases.

The proper selection of furnace capacity is of great importance. Installation of heavy-duty furnaces when operating on the seasonal power schedules reduces the coefficient of utilization of the hydroelectric station; the installation of small furnaces causes a sharp increase in the unit power consumption rate which, in turn, causes an increase in the unit capital investment per production ton.

Analysis of the factors involved /data given in tables and graphs in original/ shows that the unit capital investment per rated kilowatt is reduced with an increase in power of the electrical installation. On the other hand, the efficiency per rated kilowatt for stations operating on an unregulated water flow decreases with an increase in power because the greater the discharge utilized, the shorter its duration. In accordance with this, the economic indices of both the hydroelectric station and the factory are greatly affected. Furthermore, as the index for water-flow utilization changes, the engineering-economic indices for the hydroelectric station and the factory diverge sharply. All this confirms the conclusion that the problem of utilizing seasonal hydroelectric power can be properly judged only after working out the engineering-economic indices for a given water flow in the combined hydro station-electric furnace aggregate. Analysis of the power-economic indices on the basis of the hydroelectric system alone invariably leads to one-sided and incorrect conclusions.

Another aspect of the problem was to compare the basic economic indices of a hydro station with that of a steam station, taking into account the latter's fuel base. It was found that a hydro station would pay for its capitalization much sooner than would a steam station. In addition, studies showed that labor productivity for the factory-hydro aggregate and factory-steam aggregate was about the same when the seasonal operation was 50 percent of normal operation.

Conclusions

Allocation of electric furnaces to areas having hydroelectric power resources available on a seasonal basis will make possible more efficient utilization of the water-power resources by increasing the coefficient of flow utilization.

Electric furnaces can be operated advantageously on the seasonal power schedule from the viewpoint of power engineering, technology, and economics. In this capacity, the furnaces become profitable consumer regulators.

Generalization of long experience in electric-furnace operation leads to the conclusion that, according to the basic indices (labor productivity, cost of production, and effective utilization of capital investments), operation of electric furnaces on the seasonal schedule of the hydroelectric station (for a minimum of 6 months) is more profitable than operation of furnaces from steam-electric stations on the normal schedule (for hydroelectric power cost up to 2.2 kopecks per kw-hr, and steam-electric power cost of 5 kopecks per kw-hr and higher).

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